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DEVELOPMENT OF LIQUID ANNULAR RING TYPE
OF AIR COMPRESSOR

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During the first year of this project, the compression of air in a rotating casing containing a layer of cooling water eccentrically mounted relative to a partitioned rotor was investigated. The construction and test of a prototype were reported in the first Annual Report (May, 1952). The results of the tests showed the loss from a pressure-fed, outboard sleeve-bearing to be inordinate and indeterminate and this line of investigation was discontinued. A prototype utilizing ball bearings exclusively is now being constructed, details of which will be discussed in a later report.

Figure II of the first Annual Report gives a comparison of various losses. It appeared that the loss due to water movement was quite high. A consideration of events taking place in a pocket indicates that as the air pressure builds up in the pocket the water is displaced. Centrifugal force on the water in the pocket does not manifest itself until there is a difference in head between the water in the pocket and the ambient water, i.e., the water on the sides of the rotor and in the other pockets. Some of the displaced water flows over the circular edge where only a small amount is necessary to build up a pressure differential. The remainder, and larger portion flows into other pockets over the longitudinal edge of the blade. The volume of this displaced water may be quite large, amounting to 10 to 25 per cent of the volume of air.

To determine whether this explanation was correct an old pump was modified as follows. A six pocket rotor was constructed and the sides of each pocket made parallel as shown in Figure I. A curved rectangular float (see Figure II) was fitted rather loosely (clearance of 1/16") within each pocket. Attached to the floats are two bronze cables the ends of which are soldered to caps projecting radially from the outside of the casing. (In the illustration only two caps are shown on the casing. There will be five other pairs displaced 60° from each other around the periphery.) The length of the cable is such that the float will clear the rotor core by 1/16 inch. The floats are made of wood and designed to stay on the surface by flotation until 1/8 inch of depth is uncovered.

In order to keep the cable from fouling up, it is necessary to drive the casing positively and at the same angular speed as the rotor. This was accomplished by a simple universal, shown schematically in Figure III, consisting of a short rod with two slotted balls (slots at right angles) brazed to its ends. Within the slots are small drive rods which extend into the rotor and/or the casing. When the air is compressed in the pocket, only the relatively small amount of ~~inertia~~ water in the clearance space around the float will be displaced.

Considerable difficulty was experienced in obtaining smooth operation. The floats had a tendency to wedge themselves between the rotor and casing and, even after rotation started, there would be a sudden binding with certain destruction of float or blade. Finally, by generous filleting, rotation was obtained with considerable rumbling. The results were not good as the shaft efficiency was only 40 per cent.

Since the flexibility of the cables seemed to have promoted jamming, it was decided to substitute 1/16 inch bronze rods instead. The floats were a loose fit on the rods to allow them to line up with the surface of the water. The starting operation then became quite simple. The floats, initially thrown out against the casing by centrifugal force, were forced toward the center guided by the rods as water entered the casing. Their progress could be observed easily through the plexi-glass cover. This action of the floats showed the fallacy of the previous reasoning. It now became clear that when air pressure is applied to the float and the water in the clearance area retreats, the float follows the water instantly. So the only way to make the float stay put is to fasten it to the casing rigidly.

There are many fastening methods possible. In this case, brass sectors 1/16 inch thick were used, two of which are shown in Figure IV. Note that the floats, or segments (since they no longer need to float), are narrower than before inasmuch as a clearance space equal to the eccentricity must be allowed between blade and float. Sloshing of the water between the sides of the pocket and the rigid segment will now introduce a loss not present before. The simplicity of the pump when consisting only of rotor, casing, and water now become apparent.

Three tests were run with this arrangement. One with the segments and universal; another without the segments but using the universal; and a third with the casing free as in previous runs. As can be seen from the data given in Table 1, the results were poor indicating that the loss introduced was greater than that which occurred before improvement.

In the next report, the design and construction of a 5 HP prototype incorporating several new design features will be discussed.

TABLE 1. - PERFORMANCE DATA.

No. of Run	Pump Speed (rpm)	Amps.	Volts	Dischg. Press. #/sq.in.	Cu.Ft. Free Air	Net Motor Watts	Watts in Dischg. Air	Shaft Eff.
Run With Wood Segments and Universal								
1	3150	3.65	183	4.0	15	445	187	42
2	3150	4.0	179	4.9	13	484	195	40
3	3260	4.7	193	5.0	15	652	221	34
4	3260	5.1	191	6.0	14	703	249	35
5	3200	5.4	188	7.0	11	733	220	30
Run Without Wood Segments but With Universal								
1	3260	4.6	135	4.7	18.5	599	268	44
2	3260	4.5	185	5.0	18.5	586	273	47
3	3260	5.3	188	6.0	16.2	718	288	40
4	3150	6.1	180	7.0	15.	789	300	38
Run Without Segments or Universal								
1	3200	3.6	135	3.6	17.5	443	201	45
2	3150	4.0	181	4.0	17.5	491	219	44.5
3	3150	4.7	183	5.0	15.0	604	221	36.6